Senior Thesis

Fish Fauna from the Second Middle Devonian Bone Bed of Central Ohio (Eiffelian)

by
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ABSTRACT

The Second Bone Bed of central Ohio is the "classic" Middle Devonian bone bed of this region. Two localities were sampled, and a variety of plates, scales and teeth were recovered. The plates and scales were diagnostic to the species level, in constrast to the teeth. Two species of agnathids, OHIOASPIS TUMULOSUS AND O. IMPOSITUS; seven species of acanthodians, CHEIRCANTHOIDES COMPTUS, C. VENUSTUS, C. BREVIPLICATUS, HELOLEPIS BELLARUGOSUS, H. VENUSTILOIDES, ACANTHOIDES? SCIOTOENSIS, A.? DUBLINENSIS; and one species of sarcopterygian ONYCHODUS SIGMOIDES were recovered.

The classification scheme followed by Wells (1944b) was chosen for acanthodians over that of Denison (1979). Denison synonymized all the acanthodian scales of CHEIRCANTHOIDES and HELOLEPIS into C. COMPTUS. Examination of Wells' material resulted in no reasonable explanation for this synonymy. Therefore, Wells' 1944b classification was used instead of Denison's 1979 classification scheme.

INTRODUCTION

A thin concentration of fish remains and crinoid columnals is present at the base of the Eiffelian Delaware Limestone in central Ohio. Popularly known as the Second Ohio Bone Bed, this thin layer, averaging approximately 5 cm, is a very minor portion of the strata in central Ohio, yet it has received popular interest from amateur fossil hunters to emeritus professors. Many hours have been spent trying to find "the bone bed", difficult as it is to find, with the hopes that an ever-valuable shark's tooth can be found.

Although Orton (1878) described it as "... one of the most remarkable layers in the entire series of American Paleozoic deposits", few in depth investigations have been undertaken since Wells' series of papers in 1944. Recently, Conkin and Conkin (1975) investigated the central Ohio bone beds as part of a larger series of papers on bone beds in the Midwest. These papers, however, have received much criticism from the professional community as will be detailed below. The purpose of this work, therefore, is to re-introduce the Second Bone Bed of central Ohio back into the literature in hopes that it will stimulate further research. This will be done by giving first, an overview of the occurrence and possible origins of the bone bed. This will be followed by a systematic description and classification of a sample

of specimens collected by the author. Two species of agnathids, OHIOASPIS TUMULOSUS and OHIOASPIS IMPOSITUS; seven species of acanthodians, CHEIRCANTHOIDES COMPTUS, C. VENUSTUS, C. BREVIPLICATUS, HELOLEPIS BELLARUGOSUS, H. VENUSTILOIDES, ACANTHOIDES? SCIOTOENSIS, A.? DUBLINENSIS; and one species of sarcopterygian, ONYCHODUS SIGMOIDES were recovered.

The Second Bone Bed was first reported in 1873 by Newberry in his survey of the geology of Ohio. Orton (1878) gave another general overview. In the early 20th Century, a series of papers appeared that attempted to find the origins of bone beds in general with particular interest in the Second Bone Bed (Stauffer, 1909; Stauffer, Hubbard, and Bownocker, 1911; Kindle, 1919; Westgate and Fischer, 1933; Brotzen, 1934). Wells (1944a, 1944b) published a pair of papers that provided detailed systematic descriptions of the fish remains along with possible origins of the beds. Wells' papers are the primary references for this thesis.

METHODS

The Second Ohio Bone Bed was sampled at two separate localities in Franklin and Delaware counties, Ohio. The samples were broken into small chunks and dissolved in hydrochloric acid. The insoluble residue was then picked for vertebrate material. All scales and plates were then prepared for examination and classification. Photographs were taken on a scanning electron microscope (SEM).

Regional Overview

In the Middle Devonian of Ohio, Kentucky and Indiana, seven major bone beds are present, all surrounding the Cincinnati Arch. Four bone beds are present in central Ohio within two formations: the Columbus Limestone and the Delaware Limestone both of Eiffelian age. The First bone bed occurs roughly 10 feet below the top of the Columbus Limestone and outcrops in Franklin and southern Delaware counties. The Second bone bed occurs at the contact of the Columbus and Delaware limestones and outcrops from central Ohio to Lake Erie. The Third bone bed occurs approximately 25-30 feet above the Columbus-Delaware contact and outcrops in Franklin and Delaware counties. The Fourth, and uppermost, bone bed occurs two feet above the Third and outcrops only at Delaware, Ohio (Wells, 1944b).

Three other bone beds flank the Cincinnati Arch outside central Ohio. The Rocky Branch bone bed correlates with the Second bone bed of central Ohio. It outcrops near the top of the Jeffersonville Limestone in southeastern Indiana (Wells,1944b). The East Liberty bone bed outcrops in Logan County, Ohio approximately 50 miles west of the four central Ohio bone beds. Stratigraphically, it lies between the Columbus Limestone and the Ohio Shale in the Bellefontaine Outlier. The upper part of the Columbus Limestone is missing there. The Kiddville Layer outcrops

in central Kentucky at the base of the Boyle Limestone. The Kiddville was thought to correlate stratigraphically with the East Liberty bone bed (Wells,1944c).

THE SECOND BONE BED

The Second Ohio Bone Bed is the lowermost bed of the Eiffelian Delaware Limestone. Conkin and Conkin (1973) stated that it lies above a paracontinuity between the Delaware and the late Eiffelian Columbus Limestone. A paracontinuity is a disconformity which exhibits a slight, although significant, faunal discontinuity and slight, although clearly discernable, channeling of the underlying rocks (Conkin and Conkin, 1973). Paracontinuities have a basal detrital unit, such as a bone bed.

The Columbus Limestone is composed of carbonate mudstones and packstones with some grainstones. The lower portion is grayish in color, whereas the upper portion is bluish in color. The formation is medium-bedded with a more or less tabular geometry and is dipping slightly toward the east. Chert lenses and nodules are common. Bedding contacts are very irregular and undulatory. Stylolites are common throughout. The upper part is very fossiliferous with a wide range of invertebrates present. Lenses of crinoidal grainstones are common.

The Delaware Limestone is a fossiliferous packstone that grades upward into a wackestone. Overall, it is thin bedded and planar. It is more silty than the Columbus with chert nodules

present. The ichnofossil Zoophycos is common.

The bone bed itself is a zone of concentrated pelopsammic material. Phosphatic remains and phosphatized fossils, other than fish, include conodonts, arenaceous foraminifera, scolecodonts and crinoid columnals. Crinoids are the dominant skeletal elements. According to Antia (1979) a bone bed must have at least 4.5% phosphatic material, thus categorizing it as a phosphorite. The Second Bone Bed falls into this category with the phosphate a carbonate apatite (Westgate and Fischer, 1933).

ORIGIN OF THE SECOND BONE BED

Many attempts at explaining the origin of the bone beds have been made. Most explanations have fallen into two groups: catastrophe and concentration by reworking of the sediments. Most theories prior to Wells'(1944a) paper relied on catastrophic causes.

Wells (1944a) argued against catastrophe as the cause and asserted that the Second Bone Bed was formed by concentration of the remains by environmental forces. Wells rejected catastrophe for a number of reasons. First, the remains are well-sorted and with few exceptions worn and abraided. With a sudden influx of large numbers of carcasses, neither of these conditions would be expected. Second, no complete or partially complete specimens are present. In sediments where mass mortality has most assuredly

taken place, whole or partial specimens are common. Last, the relation of the bone bed with the top of the underlying Columbus Limestone leads one to believe that an extensive amount of reworking of the sediments has taken place.

Wells (1944a) argued that the Second Bone Bed represents a diastem that resulted from fluctuation of the bottom of a very shallow sea floor with respect to wave base. The bottom was at or above wave base over a wide area which caused extensive development, erosion and redeposition of lag concentrate deposits. The bone bed occurs in the hollows of the top of the Columbus Limestone. Its thickness constantly varies from zero to about 20 centimeters which would be expected of a lag concentrate deposit.

Antia (1979) reviewed bone beds worldwide, including the central Ohio bone beds. He stated that the explanation given by Wells (1944) is probably the best available so far. Note must be taken, however, that several mistakes were present throughout Antia's account of the Ohio Bone Beds.

TAXONOMIC NOTE ON SYNONYMY

According to Wells (1944b), the scales belonging to the Class Acanthodii were classified into three genera and several species. This classification was based upon the external morphology of the scales, especially the coronal surface. Brotzen (1934) stated that each acanthodian has a characteristic scale in general make-up and outline over the whole body, except the head, and that the scale type can be used for systematic purposes. If we accept Brotzen's claim, then Wells is correct in assigning the different scales to different genera and species.

In contrast, Denison (1979) lumped all the species of *Cheircanthoides* and *Helolepis* into *C. comptus*. However, he did not give any reasoning or evidence for this synonymy. He may have based it on histological grounds, but this was not stated.

Denison (1979) also stated that *Acanthoides dublinensis* Stauffer was definitely not *Acanthodes*, although he did not identify its generic affinities. Wells (1944b) followed Stauffer (1909) and therefore misnamed *Acanthoides sciotoensis*. If Wells' classification is to be used, this discrepancy must be taken into consideration.

The scales collected in this study were distinct enough in external morphology and are fairly distinct forms so that the classification followed by Wells (1944b) seems appropriate. Histological investigation was not attempted, and no other reason can explain Denison's synonymy. Therefore, the classification

system followed in this thesis is that of Wells (1944b). Question marks have been inserted in the Acanthoides genera, however, to signify that this assignment is questioned.

SYSTEMATIC PALEONTOLOGY

Class AGNATHA Owen
Subclass CEPHALASPIDOMORPHA
Order OSTEOSTRACI
Family CEPHALASPIDAE Owen
Genus OHIOASPIS Wells

OHIOSPIS TUMULOSUS Wells, 1944b

Plate 1, Fig. 1,2

DESCRIPTION. - Small to medium tuberculated tesserae, rhomboidal to sub-rhomboidal in outline where not fractured. Tubercles commonly stellate reaching up to 1mm above base. Tubercles commonly clustered centrally with unornamented margin but may extend to periphery. Central tubercles commonly higher than marginal tubercles. Bases of tubercles overlap one another. Base of tessera may be flat but commonly convex.

DISCUSSION. - The tubercles of these tesserae show wide variation, and on this basis Wells (1944b) described four formae:

1) forma typicus - Tubercles broad, low, rounded, with low ridges radiating from the summits; closely packed basally. Scales dimensions averaged: width 1.6mm, length 1.2mm, and heigth .6mm. (Pl.1, fig.1)

2) forma turritus - Tubercles subcylindrical, with blunt, rounded tips and 5-8 narrow buttress-like lateral supporting ridges of dentine. Ridges notched at upper edges, expanding outwards basally, separated by deep grooves.

3) forma hystricosus - Tubercles similar to those of forma turritus but taller, more slender, with tips produced to an acute point, rarely more than three in number.

4) forma clavulus - Tubercles bulbous, striated or with low ridges, on constricted stellate bases. Mucous grooves very weak. Top of tubercles usually worn flat, suggestive of a ventral position on the body of this type.

Scale dimensions averaged: width .8mm, length .6mm, and heigth .2mm. (Pl.1, fig. 2)

Only two formae were recovered by the author: formae typicus and clavulus.

The tessera designated as typicus is clearly of this forma. Twelve stellate tubercles are differentiated and are broad, low, and basally closely packed. A thin margin separates the tubercles from the periphery of the tessera.

The tesserae designated as forma clavulus were included in this forma due to the bulbous tubercles with some low ridges. They were not included in forma turritus because they are close packed with no separation by deep grooves.

OHIOASPIS IMPOSITUS Wells, 1944b

Plate 1, Fig. 3

DESCRIPTION. - Small to medium tesserae, rhomboidal with ten or more sellate tesserae situated on strongly convex base. Tubercles are closely packed in central portion. Tubercles rise abruptly from base with entire cluster mimicking overall outline of tessera. Base has grooves running from tubercle cluster to the periphery and situated roughly perpendicular to them. Scale dimensions average: width 1.5mm, length 1.0mm and heigth .6mm.

DISCUSSION. - The tessera recognized as O. impositus has all of the characteristics outlined above. Roughly 20 tubercles can be recognized mainly by the tips due to close packing. The stellate pattern can be determined in a few tubercles, however. The tubercle cluster rises very abruptly and closely resembles the overall outline of the tessera.

Class Incertae Sedis ACANTHODII Owen
Order CLIMATIIFORMES Berg
Family CLIMATIIDAE Berg
Genus CHEIRCANTHOIDES Wells, 1944b

CHEIRCANTHOIDES COMPTUS Wells, 1944b

Plate 2, Figs. 1

Description. - Small to medium scales with nearly flat rhomboidal to sub-elliptical crown, ornamented with ridges, a variably constricted neck with canal pores and a thick, rhomboidal base. Crown may be narrower or wider than base with the posterior corner projecting beyond base. Coronal ridges may be weakly to strongly developed, rarely bifurcating, converge posteriorly and extend varying lengths across the crown. Scale dimensions average: width 1.0mm, length 1.0mm, and heigth .8mm.

Discussion. - This is the most common fish remain in the central Ohio bone beds (Wells, 1944c). Wide morphologcal variation exists in this scale type especially in the crown. The crown can be either wider or narrower than the base, may or may not extend anterior to the base at the anterior margin, have a wide variation in number of ridges and height of ridges, and the ridges extend various distances across the surface. Most of the ridges do, however, converge posteriorly and extend halfway across to the posterior corner. The posterior corner, where not abraided, usually extends far beyond the base. Several of the specimens collected have excellent preservation of the posterior canal pores on the neck and ascending tubes rising to the ventral side of the posterior corner.

An interesting deviation from the common type was described by Wells (1944c), in which a second set of ridges radiated from a point midway on the coronal surface. Another find by Wells (1944c) was a pair of fused scales. These rare scales were not found by the author.

CHEIRCANTHOIDES VENUSTUS Wells, 1944b

Description.- Medium to very large scales, with crowns much smaller than bases, an unconstricted neck and a thick base. Crown has varying number of low ridges which converge posteriorly to a

point which rises slightly above the coronal surface. Owing to the relatively small size of the crown, the neck is not constricted. The base is commonly centered slightly anterior to the center of the crown. Scale dimensions average: width 1.8mm, length 1.8mm, and heigth 1.5mm.

Discussion.- This scale type is very striking in its general appearance. The small crown and anteriorly-centered base are characteristic. This scale type is not common in the Second Bone Bed.

CHEIRCANTHOIDES BREVIPLICATUS Wells, 1944b

Plate 2, Figs.2

Description. - Medium size scales with broad, sub-elliptical crown, thin constricted neck and a very short base. Crown flat bearing 10 to 15 low ridges converging slightly posteriorly. Scale dimensions average: width .8mm, length .6mm, and heigth .4mm.

Discussion. - This scale type is distinctive in its overall appearance but may be similar to C. comptus in coronal appearance. The low, almost flat base is diagnostic of this type, with the broad sub-elliptical appearance very characteristic. The abraided scale with a sharply overhanging posterior corner was included with this type for these same reasons.

HELOLEPIS BELLARUGOSUS Wells, 1944b

Plate 2, Fig. 3

Description. - Small to medium scale with quadrangular crown, short constricted neck and a thick base. Crown as wide as base, sloping down anteriorly with six coarse, parallel ridges extending halfway to posterior corner. Scales dimensions averaged: width .5mm, length .6mm, and heigth .5mm.

Discussion. - This scale is distinctive due to the coarse ridges which are parallel, rather than converging posteriorly and by the crown having a sub-quadrangular outline with a width equal to the basal width. Wells (1944b) found a sample with three scales fused together and overlapping approximately one quarter of the adjoining scale.

HELOLEPIS VENUSTILOIDES Wells, 1944b

Plate 2, Fig. 4

Description. - Small to medium scales with sub-elliptical to sub-quadrangular crown, slightly constricted neck and a well-developed base. Coronal surface inclined gently anteriorly with two to five parallel ridges. Crown much narrower than base with posterior corner extending beyond base. Base centered slightly anterior to center of crown. Scale dimensions averaged: width .5, length .8, and heigth .5mm.

Discussion. - These scales may resemble closely those scales of Cheircanthoides venustus. They can be distinguished by the inclining coronal surface with a smaller number of parallel ridges (Wells, 1944b).

Two of the scales were included in this species due to the small number of parallel ridges. Otherwise, they closely approach C. venustus.

ACANTHOIDES? SCIOTOENSIS Wells, 1944b

Description. - Small scales with elliptical crown, slightly constricted neck and a low base. Coronal surface slopes down anteriorly and is as wide as the base. Surface is not ornamented but has a smooth, glistening surface. Neck rises posterior to posterior corner of crown. Base rhomboidal.

Discussion. - The coronal surface of this specimen was determined to be un-abraided due to the smooth sheen on the surface. The elliptical shape of the crown with a smooth surface coupled with the overall thinness of the scale placed it within this species.

Denison (1979) stated that the type specimens that Wells (1944b) described for the species are surely not those of Acanthoides. He did not, however, state to which genus they belonged. Therefore, I have followed Wells' 1944b classification but have inserted the question mark.

ACANTHOIDES? DUBLINENSIS Stauffer, 1909

Plate 3, Figure 1

Description. - Small to medium scales with sub-rhomboidal crown, a constricted, thick neck and a deep base. Crown as wide as base, with smooth glistening surface. Posterior corner extends slightly beyond base. Base centered slightly anterior to crown. Scale dimensions averaged: width .6, length .6, and heigth .6 mm.

Discussion. - The coronal surface of this scale was also determined to be unornamented. The posterior portion is abraided but, the anterior portion, where ridges normally originate is smooth and glistening. Thus, the entire surface was probably not ornamented with ridges. This species can be distinguished by its thick, broad appearance with the coronal surface level and not sloping anteriorly.

Denison (1979) also stated that the specimens described by Stauffer (1909) were not Acanthoides. Wells (1944b), following Stauffer, therefore described this species in the wrong genus. This specimen has been included in Acanthoides? for the same reasons as Acanthoides? sciotoensis.

PRESUMED ELASMOBRANCHII REMAINS NOT IDENTIFIABLE TO ORDER

OHIOLEPIS NEWBERRYI Wells, 1944b
Plate 1, Fig. 2

Description. - Medium-sized denticles, strongly quadrangular to irregularly rhomboidal in outline, consisting of broad crown heavily ornamented with tubercles and a shallow convex featureless base. Tubercles elongate, spine-like, lying close-packed in antero-posterior orientation. Tubercles slope anteriorly and may slope posteriorly. Tubercles may have indentations medially. Tubercle size increases from center toward margin. A narrow plain margin surrounds the unornamented center. Dimensions average: width .6mm, length 1.2mm, and heigth .2mm.

Discussion. - The denticles are very striking in appearance and are easily identifiable. The tubercles are much shorter than those of Cladolepis which extend the length of the crown.

The denticles of the three specimens determined as O. newberryi are very different in appearance. On one scale the tubercles are indented medially, whereas the other two are not. The tubercles are rod-like but differ in size orientation. On one they increase in size from the center outwards, whereas on the other they decrease marginally. Nevertheless, Wells included all three within the same species, and therefore so do I. Further investigation however is needed.

Class OSTEICHTHYES
Subclass SARCOPTERYGII
Order CROSSOPTERYGII
Suborder ONYCHODONTIFORMES
Family ONYCHODONTIDAE Woodward
Genus ONYCHODUS Newberry, 1857

ONYCHODUS SIGMOIDES Newberry, 1857
Plate 3, Fig. 3

Description. - Small to very large fragmented denticles, very thin, ornamented with numerous horseshoe-shaped cusps that slope anteriorly. Cusps weakly attached to denticles. Coronal surface may be featureless or ornamented with small strongly parallel ridges with the cusps superimposed upon them. Cusps may occur randomly or in a linear pattern.

Discussion. - This scale type is very distinctive and cannot be mistaken for any other type in the bone beds. The horseshoe-shaped cusps that are not close-packed easily distinguish this type from Ohiolepis, Wells.

The denticles of this type are very large, and thus, fragments only are found. Special care must be taken when handling these specimens as the cusps readily separate from the denticle. This type is very common within the bone beds (Wells, 1944b).

SUMMARY

The Second Ohio Bone Bed was observed and sampled in two places along the Scioto River in Franklin and Delaware Counties. Several species were identified and classified according to Wells (1944b). No new genera or species were found. Wells' (1944b) classification scheme for acanthodians was followed instead of Denison's (1979), because no reasons for synonymizing the genera was found by the author.

The Second Bone Bed is not the result of a catastrophic annihilation of a fish fauna. It is a lag concentrate produced by fluctuations of the sea floor with respect to wave base.

The bone bed occurs in the troughs and low areas of the top of the Columbus Limestone. It should therefore be considered the basal unit of the Delaware Limestone.

LOCALITIES

1) Small, abandoned quarry on west side of Olentangy River located on Powell 7.5 min. Quadrangle, Delaware County, Ohio; T.3N, R.19W; 1/4 mile north of Thomas Cemetery.

2) East wall of Marble Cliff Quarry located on Southwest Columbus 7.5 min. Quadrangle, Franklin County, Ohio; T.5N, R.22W; NE 1/4 of NE 1/4 of Section 3; just west of McKinley Road directly behind Campbell Memorial Park.

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PLATE 1 DESCRIPTIONS

Figure 1. - OHIOASPIS TUMULOSUS Wells, 1944b forma typicus, oblique view showing close-packed, stellate tubercles. (X50)

Figure 2. - OHIOASPIS TUMULOSUS Wells, 1944b forma clavulus, coronal view. (X75)

Figure 3. - OHIOSASPIS IMPOSITUS Wells, 1944b Oblique view showing close-packed tubercles rising abruptly from center of denticle. (X50)

PLATE 1

Figure 1

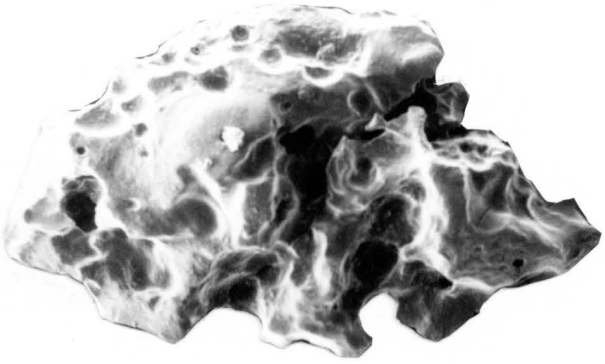

Figure 2

Figure 3

PLATE 2 DESCRIPTIONS

Figure 1. - CHEIRCANTHOIDES COMPTUS Wells, 1944b
Coronal view showing converging ridges. Posterior crown and margins abraided. (X80)

Figure 2. - CHEIRCANTHOIDES BREVIPLICATUS Wells, 1944b
Coronal view showing broad, elliptical outline of scale. (X85)

Figure 3. - HELOLEPIS BELLARUGOSUS Wells, 1944b
Coronal view showing sub-quadrangular outline with parallel ridges. (X100)

Figure 4. - HELOLEPIS VENUSTILOIDES Wells, 1944b
Coronal view showing sub-elliptical outline with small number of large parallel ridges. (X100)

PLATE 2

Figure 1

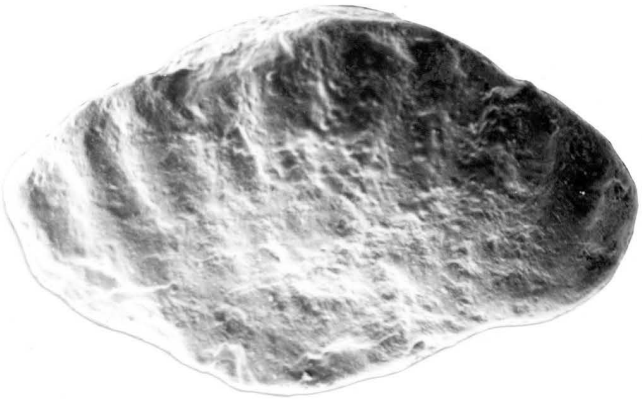

Figure 2

Figure 3

Figure 4

PLATE 3 DESCRIPTIONS

FIGURE 1. - ACANTHOIDES? DUBLINENSIS Stauffer, 1909
Coronal view showing sub-quadrangular outline with smooth surface. (X110)

Figure 2. - PRESUMED ELASMOBRANCHII REMAINS NOT IDENTIFIABLE TO ORDER.
OHIOLEPIS NEWBERRYI Wells, 1944b
Dorsal view showing close-packed, tubercles. (X63)

Figure 3. - ONYCHODUS SIGMOIDES Newberry, 1857
Dorsal view showing horseshoe-shaped cusps superimposed upon parallel ridges. (X87)

PLATE 3

Figure 1

Figure 2

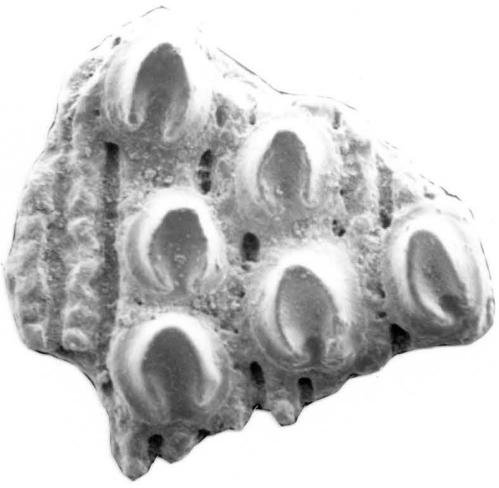

Figure 3